

The challenges of Arctic reindeer herding: The interface between reindeer herders' traditional knowledge and modern understanding of the ecology, economy, sociology and management of Sámi reindeer herding.

Inger Marie G. Eira, Ole Henrik Magga, Mathis P.Bongo, Mikkel Nils Sara¹, Svein D. Mathiesen² and Anders Oskal³.

Abstract

Sámi reindeer herding is practiced in Norway, Sweden, Finland and Russia. More than 20 arctic indigenous peoples, herd reindeer in the circumpolar North including 100.000 herders and about 2.5 million semi-domesticated reindeer. Sámi reindeer herding represents roughly one third of the world's reindeer herding and it's traditional practices, ancient in origin, represent models sustainable of exploitation and management northern terrestrial ecosystems that is based on in generations of traditional knowledge accumulated, conserved, developed and adapted to the climatic and administrative systems of the north.

Reindeer herders in the Arctic today face global challenges related to changes in their societies, including changes in traditional land use (loss of grazing land) and climate change. Simultaneously, there are restrictions on the practice of traditional knowledge, restrictions that could either turn reindeer herders into 'lawbreakers', or could make their societies more vulnerable to the changes at hand.

This paper reports preliminary results from the IPY EALÁT project which adopts a novel methodological approach in analyzing the multi-functional nature of Sámi reindeer herding. The EALÁT project is a multidisciplinary project research and it integrates research, outreach and education.

Recognizing that the ability to adapt to change is based on the traditional and indigenous knowledge base and traditional institutions within Sámi reindeer herding, it is decisive that modern reindeer herding regimes recognizes this as a starting point. This article exemplifies the challenges that traditional reindeer herding faces in the interface of traditional and modern understandings of the ecology, economy, sociology and management of reindeer herding in Finnmark, Norway. These aspects will be discussed in the light of the traditional organization of reindeer herding, the traditional handling of reindeer, animal welfare, slaughtering and food production and the knowledge base surrounding the livelihood. It is critical to empower indigenous peoples with the best technologies available that can be combined with indigenous knowledge for advancing the development of sustainable development of reindeer herding. It is essential therefore that education and management institutions are transformed in order that they are able to use and understand reindeer herders traditional knowledge.

Keywords: reindeer herding, traditional knowledge, climate change, Sámi terminology, snow, sustainable development

¹ All from Sámi University College, 9520 Guovdageaidnu/Kautokeino, Norway

² Norwegian School of Veterinary Science, 9292 Tromsø, Norway

³ International Centre for Reindeer Herding, 9520 Guovdageaidnu/Kautokeino, Norway

1. INTRODUCTION

This paper reports on early findings in the multidisciplinary IPY project EALÁT, and gives examples of traditional knowledge within reindeer herding and discusses how this kind of common knowledge could be included into management and education systems. In this situation, we need the best knowledge available. The challenge for the mainstream society is to take reindeer herders' knowledge into action for the sustainable development of the Arctic regions. The challenge for Sámi reindeer herders is to develop a system for sharing and coproduction of common traditional knowledge in order to develop co-management systems in the circumpolar north where their voice is heard. First we give a brief presentation of reindeer herding and a description of the challenges it is facing today, with Sámi reindeer herding as an example. We describe its organization and its adaptation strategies to changes. We focus in particular on the knowledge base reflected in the specialized language and terminology that has been accumulated through millennia. Some of the structure of the terminology on snow is described and exemplified and the experiences from field study of snow conditions from the reindeer herding year 2007-2008 are summed up.

More than 20 indigenous peoples and as many as 100.000 individuals are reindeer herders across Eurasia. (ACIA 2004). Reindeer herders in this region face major challenges related to changes in their society such as loss of grazing land, climate changing and neglect of their common traditional knowledge about reindeer, environment and land use accumulated through generations in the administrative systems established by governments. The survival and development of reindeer herding is therefore also a question about diversity, both cultural and biological.

Reindeer herding in the arctic is a complicated interplay between animals, land and human activities. Reindeers' niche has always been the edge of the snow- and ice-covered areas in the north. Changes in this area combined with the seasonal variations, which are dramatic in themselves, have forced both reindeer and the human beings that depend on them, to adapt to new conditions, varying from season to season and year to year. With increasing industrialization and other kinds of human activities, new economic standards for family economies and environmental changes, new challenges have arisen and the very survival of reindeer herding as an economic base is at stake (Tyler et al. 2007).

2. IPY EALÁT

The International Polar Year (IPY) EALÁT⁴ consortium (IPY project no 399) was initiated by *Association of World Reindeer Herders* (WRH) and is a follow-up of the Arctic Council report *Arctic Climate Impacts Assessment* ACIA (2004). The project focuses on adaptation to the projected future climate change in the North with an ideological basis in the UN Rio Declaration of 1992, Convention on Protection of Biological Diversity of 1992 and the Jakutsk declaration 2005 from the Assembly of World Reindeer Herders.

⁴ EALÁT is a Sámi word with the meaning "something to live on (especially for reindeer), (sufficient) pasture" (Nielsen 1932-62, 1979 III:861) and it originates from word *eallit* which means 'to live' and emphasis the meaning of cultural sustainability. The term for 'reindeer herd' in Sámi is *eallu*, which is also derived from *eallit*.

The consortium comprises research, teaching, outreach, monitoring and information projects including reindeer herders communities in Eurasia and Alaska.

(<http://www.ealat.org>) The research part (EALÁT RESEARCH) is funded by the Norwegian Research Council and other sources for the years 2007-2010 and it is divided into eight different “working packages”, focusing on meteorology, land use change, traditional knowledge, linguistics, social science, economy, ecology, animal physiology and welfare, vulnerability analyses and teaching.

EALÁT-RESEARCH recognizes the fact that the ability to adapt to change is based on knowledge embodied in the philosophy, language and institutions of herding and put into practice by the action of communities and individual herders. The research focuses on the adaptive capacity of reindeer pastoralism to climate variability and change and, in particular, on the integration of reindeer herders' knowledge in the study and analysis of their ability to adapt to environmental variability and change. It aims at determining the extent to which the meteorological parameters can provide a biologically meaningful description of the local conditions that influence the food supply for reindeer. It will summarize and compare scientific data and codified versions of herders' knowledge about the effects of variation in winter weather on the availability of forage for reindeer in winter and the growth and quality of forage in summer. A central task is to codify herders' experience and perception of climate change, their coping mechanisms and their perception and assessment of risk associated with different coping options. There is also a need to determine what non-climate factors influence herders' ability to adapt to changing climate conditions and the constraints on, and opportunities for, coping associated with national and international institutions, governance and customary rights. One part aims at determining the independent effects of climatic perturbation on the lifetime productive performance of female reindeer. One goal is to determine the effects of local climatic variability and climate change on nutritional status and welfare of reindeer through understanding of physiological adaptation to change. Finally, the information gathered through the seven tasks will be synthesised at two levels: within Finnmark in Norway and between Finnmark and Yamal in Russia. The team will analyse and compare the vulnerability, resilience and sensitivity of the reindeer herding community to the interacting forces of change.

Facing dramatic changes, both reindeer herders and governmental authorities need the best knowledge that is available. In the course of the last 30-40 years much research has been conducted on biological aspects of the life of reindeer and also on social aspects of reindeer communities. Today, there is a growing understanding of the need for a more holistic perspective on the management of nature and environment in the Arctic. The reindeer herding peoples hold a unique knowledge of climate, nature and environment, which has not so far been superseded by other kind of knowledge in the daily management of a reindeer herd, should be integrated and combined with research-based knowledge and used on all levels. It is also ambitions of EALÁT that knowledge should be put into use immediately where it is developed and documented together with other knowledge. Such exchange of knowledge and competence building is possible only by activating those who hold traditional knowledge – i.e. involving such holders as equal partners and co-producers of knowledge. The project have been initiated locally and is coordinated by the Sámi University College in Guovdageaidnu/Kautokeino, Norway, under the direction of a professor in animal physiology (Svein Mathiesen) and a professor in Sámi linguistics

(Ole Henrik Magga) with partners from many fields in many countries, among them NASA, The Norwegian Meteorological Institute, the University of Tromsø and The Norwegian School of Veterinary Science. The International Centre for Reindeer Husbandry, which is also in Guovdageaidnu/Kautokeino, handles outreach and information.

3. REINDEER HERDING

3.1 The concepts of reindeer herding and reindeer husbandry

The distinction between the concepts of reindeer 'herding' and reindeer 'husbandry' (Paine 1994, Sara 2001) is actually used in both scientific literature and practical division of rights and responsibilities. Reindeer herding is a general, inclusive term that refers to the possession, maintenance and management of the herd as the harvestable resource of its owners. Herding refers to 1) the gathering and moving of herds to pasture and 2) having reindeer under one's supervision without necessarily tending them continuously. Common to both herding and husbandry is that responses to sporadic and unpredictable changes in the physical environment are frequently discretionary. In deference to convention, we refer to reindeer pastoralists as 'herders', irrespective of the distinction between herding and husbandry. (Tyler et al 2007:192) In this article the term *reindeer herding* will be used as a broad term including both herding and husbandry.

3.1.1 Circumpolar reindeer herding – An indigenous livelihood facing global challenges

Reindeer herding is today practiced in Norway, Sweden, Finland, Russia, Mongolia, China, Alaska, Canada and Greenland, and involves around 2.5 million semi-domesticated reindeer which graze approximately 4 million square kilometers of pastures in Eurasia (Op. cit). Reindeer herding has a major cultural and economic significance for indigenous peoples in the North, and in addition wild reindeer and caribou are also hunted by other groups of indigenous people in the Arctic (UNEP, 2001).

Today, reindeer herding societies face major challenges, such as effects of global change affecting their local societies, climate change in the Arctic and loss of grazing land (UNEP, 2001; ACIA, 2004; AHDR, 2004; Tyler et al, 2007). The Arctic regions are relatively rich on natural resources like natural gas and minerals (AHDR, 2004; IEA, 2005; Wood McKenzie, 2006). As an example in the last 50 years around 25 % of the reindeer pastures of the Euro-Arctic Barents Region have in effect been lost due to human development (Tyler et. al, 2007). There are also connections between climate change and loss of pastures, which now seems to receive increasing attention from researchers, politicians and also reindeer herders themselves. At the Arctic Council Ministerial Meeting in Salekhard in Western Siberia in 2006, Chair of the Standing Committee of Arctic Parliamentarians Mrs. Hill-Martha Solberg stated: *"... We parliamentarians strongly believe the impact of climate change to be a matter of urgency. The climate change already has a strong impact on the living conditions of the Arctic indigenous peoples. And if the ice disappears for large parts of the year,*

we will see an explosion in human activities in the Arctic. We need to find ways to regulate this activity and keep ahead of the development.” A warmer Arctic is generally a more accessible Arctic, and as a result Arctic indigenous peoples will face major cultural and economic impacts as results of climate change (ACIA, 2004).

The influence of these global changes raise questions of what knowledge is needed to reduce impacts and increase the adaptive capacity of indigenous communities (ICR, 2007).

3.1.2 Reindeer herders’ knowledge – worldwide knowledge

Herding practices of reindeer herding peoples, ancient in origin, are seen to represent models in the sustainable exploitation and management of northern terrestrial ecosystems, models that have been developed over generations. It could thus be argued that reindeer herding represents a common circumpolar model for management of the remote barren areas of the north (Op. cit).

The future survival and sustainability of reindeer herding world wide depends on 1) that the traditional way of organizing reindeer herding is functional and adaptive and 2) it represents a high level of knowledge about the natural environments and climate, developed over generations, combined with functional methods of transferring knowledge from one generation to the next (which probably represents the true strength of the livelihood) and 3) the fact that reindeer herding represents a “way of life” that is professionally challenging and rewarding, and thus represents a meaningful life for people (Turi 2008). Common for all these factors is a focus on knowledge, or to be more precise the traditional knowledge of reindeer herding peoples themselves.



“One of the most important inventions for the world reindeer herding is the lasso ring. With it the human arm is extended by 15 meters, which represents the difference between life and death in the North” (Johan Mathis Turi). Here are lasso rings from Sámi and Nenets areas. Photo: Inger Marie G. Eira

Reindeer herders’ knowledge represents both traditional knowledge and indigenous knowledge. The definition of reindeer herders’ traditional knowledge fit into definitions on traditional knowledge (TK) and indigenous knowledge (IK). TK is “a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission” (Berkes 2008:7) like oral history, stories, myths, songs, lessons and more recently exists in written form. Traditional knowledge is dynamic; it is modified by its holder to reflect changes in the environment as each new generation incorporates its own empirical knowledge or local observation. (Nichols et al 2004:69) IK is a body of knowledge built up by a group of people through generations of living in close contact with nature. It is local knowledge held by indigenous peoples or local knowledge unique to a given society, including some non-indigenous ones. (Berkes et al. 2006:4). Reindeer herding has accumulated knowledge from generation to generation and this knowledge has been and still is the basis for survival and further development of the livelihood. The strong coupled reindeer-human ecosystem has been a prerequisite of this specific knowledge.

Long before the development of modern science, indigenous peoples have developed their ways of knowing how to survive and also ideas of about meanings, purposes and values. (Magga 2005:2). Likewise Johan Turi (1854–1936) “*thought that it would be a good thing if there was a book which told everything about Lapp life and circumstances... so that folk shouldn't come to twist everything round till the Lapps are always slandered, and always made out to be in the wrong when there's trouble between the Lapps and the settlers up in Norway and Sweden. In that book every event must be written down and explained so that it is quite clear to everyone.* (Turi 1939:19). This is probably the first written invitation to share indigenous knowledge with those who decide, i.e. the authorities. But very little has so far resulted from this invitation within reindeer herding. Still today we hear people complain that their knowledge is neglected and that only ‘scientific knowledge’ is paid attention to. (Joks et.al 2006) EALÁT is a contribution to the aims expressed not only by the governments, but is also incorporated in international standards like the CBD (art. 8j).

The number of reindeer in Scandinavia has varied considerably during the last 40 years (Helle & Kojola 2004). This has caused much debate. The Norwegian parliament and government has focused on setting a fixed maximum number of animals for each region. For Western Finnmark, where the field work for Ealát is carried out, the maximum number was set to 64300 while the actual size of the herds was almost 92000 in 2005. Much of the explanation to this failure seen from the governments’ side could be explained by the neglect of traditional knowledge and the herders’ right to be heard in the process (Joks et al 2006). In Canada, it has been a policy for quite a time now that traditional ecological knowledge be considered and incorporated into resource management (Manseau et al 2005: 141-143). In Norway this process is still in its infancy. This illustrates the many forces that impact on practical reindeer herding and its management. No wonder that there is uncertainty among reindeer herders when they are expected to make decisions more based on others knowledge than based on the knowledge they have used traditionally and which they have good reason to trust. The documentation of TK in this situation would also be a contribution to empowering the minority.

Traditional knowledge is a common knowledge resource of indigenous reindeer herders; an important question is how to include such knowledge in the management of natural resources locally, regionally, nationally and internationally. Capacity building in local indigenous communities is also a central element in addressing the knowledge challenges for circumpolar reindeer herders facing global change (ICR, 2007; Turi, 2008).

3.2 Reindeer herding in Sápmi

The Sámi people are an indigenous people of northern Europe inhabiting Sápmi (Sámi land), which today encompasses parts of northern Sweden, Norway, Finland and the Kola Peninsula of Russia. One of the most important livelihoods in these areas is reindeer herding. It has also been, and is, an important aspect of Sámi culture. A majority of the Sámi, participate in the local cash economy (often with one

member of the family having a regular job) and live in “lávvu”⁵ only part of the year during the migration period.

According to Sámi reindeer herding philosophy, there are some basic tenets that herders must take into account 1) reindeers’ needs related to metabolism, energy-economization and reproduction, 2) the nature of reindeer and 3) the pastoralists’ communication with the reindeer. (Sara 2008). For Sámi reindeer herders a reindeer is a self-sufficient and independent animal under the supervision of people. The reindeer lives in its habitat, its natural environment. It is an adaptable feeder which eats a variety of chemically different forages including lichens, grasses and woody plants. The herders’ way of thinking is that humans have to let the reindeer pasture as naturally as possible. The reindeer is controlled by its biological clock, time, the landscape, wind and weather. Its’ movements and roaming are decided by pasturing and by avoiding from heat and insects, *bálgan*, in different times of the year. Through the year, from one fall to the next, it pastures in different areas. The reindeer year is divided in eight seasons. The seasons determine how reindeer herding is to be managed, how the herder or herding group makes tactical (short term) and strategic (longer term) decisions. This represents the heart of the systems’ adaptive capacity.

3.2.1 Sámi reindeer herding in Norway

In Norway, reindeer herding is legally protected as an exclusive Sámi livelihood, such that only persons of Sámi descent with a linkage to a reindeer herding family can own, and hence make a living, from reindeer herding. In Norway In 2007 there was total 241521 semi-domesticated reindeer and 2936 registered reindeer owners. The reindeer pastures area Western-Finnmark, of the municipality of Guovdageaidnu/Kautokeino (69° N, 23° E) is the largest part of Finnmark. Western-Finnmark represents 38,9 % of all reindeer and 45% of Sámi reindeer owners in Norway. (<http://www.Reindrifstforvaltningen.no> 2007).



Herds of mixed age and sex varying in size from 100 to 10,000 animals are kept on natural mountain pastures all year round and typically migrate between coastal summer pastures and inland winter pastures. The inland of Western Finnmark is the winter pasture area for Sámi reindeer herders in Guovdageaidnu/Kautokeino. Their summer pasture areas are on the coasts of Troms and Finnmark. In winter herds are grazing in areas to which their owners hold the right of use. Daily herding keeps the animals gathered together as a unit. It prevents the herds of different groups from becoming mixed and most important of all it enables the herders to steer the animals towards areas where pasture is good. In spring (April and May), they and their animals generally move to the mountainous coastal region where reindeer feed throughout the summer on peninsulas or islands where they eat highly nutritious parts of dwarf shrubs, birch, willows, sedges and grasses. In September and October

⁵ Sámi tent

they are gathered and migrated towards the winter pastures which are characterized by open, upland plains of tundra and taiga birch scrub.

3.2.3 Reindeer herding society - Siida

In reality the existence and vitality of the *siida* system has been a prerequisite for successful reindeer herding all the time (Paine 1994, Sara 2001, Strøm Bull, Oskal & Sara 2001) the permanence of seasonal pastures and migration routes makes up the *siidas'* resource basis and infrastructure. In Sámi this is called *siidavuodđu*, which should be kept intact and be transferred to the next generations (Strøm Bull, Oskal & Sara 2001). Besides the land the *siida* consists of its members (*siidda olbmot*), individuals grouped in economically independent households (*báiki*). The connections between these parts of the *siida* are as follows (our translation):

The household is a group of unified individual reindeer owners, and the siida is a group of unified independent households. Family bonds are in both cases essential elements in the constellation of the group. The household doesn't own reindeers, but is a subsistence-economic base for the individual reindeer owners. The siida doesn't own reindeers and it is not a subsistence-economic enterprise, but make up the resource basis for the households.

(Strøm Bull, Oskal & Sara 2001: 278)

Thus *siida* matters mostly concern ecology, the co-ordination of herding tasks and the relations to other *siida*, i.e. the social-ecological system of *siidas*. The *siida* is an area of daily communications, conversations, discussions, decision making and evaluation on the welfare of the reindeer, pastures and land areas, weather, herding, predators, nature in general, other *siidas* movements, mixing of herds and so on. This is because the success of herding strategies depends on *siida* consensus and the members' capability of acting and exchanging information in accordance with knowledge and insight gained by regular participation in the daily life of the *siida* (Paine 1994, Sara 2001). By this the *siida* is in the best position to take care of, use and test both traditional and new knowledge, and to observe both short-term and long-term balances in the local natural and social environment.

3.2.4 Reindeer herding and adaptation to change.

The Arctic has always been dominated and influenced by periodic, irregular and often dramatic ecosystem changes, triggered by periods of warming and cooling, extreme weather events and fluctuations in animal populations. The successful long-term occupation of the Arctic by indigenous peoples has been possible, in part, because of their profound respect and understanding of their environmental surroundings (Nuttall et al. 2008).

In the case of reindeer herding, history is rich in examples of how herding strategies have enabled the livelihood to adapt to climatic variations in the past (Tyler et al., 2007). Sámi reindeer herders' oral parlances, *jahki ii leat jagi viellja* (one year is not another's brother) also give an indication that reindeer herding is based upon a continuous adaptation to changing conditions. McCarthy shows that no year is identical to the previous year when it comes to climate weather and snow conditions. (McCarthy et.al 2005)

Furthermore indigenous people's production systems in highly variable and unpredictable climates are based on the sequential utilization of, often, a large number of ecological or climatic niches (Murra, 1975). The essence of their production systems such as reindeer herding is a system with highly resilience to change and distribution of climate risk through diversity. According to Folke et al., 2002 resilience refers to the capacity to lead a continued existence by incorporating changes. Folke et al. (ibid) argue that in coupled social-ecological systems resilience is embedded in four key factors: learning to live with change and uncertainty, nurturing diversity for reorganization and renewal, combining different types of knowledge for learning, and opportunities for self-organization. Sámi reindeer herding is a true coupled human-ecosystem. One single example is the castration of male reindeer. In traditional reindeer herding even non-productive animals, such as castrates have a particular role in the herd, which reflects adaptation strategies to potentially poor grazing condition.

Recently reindeer herder Vladimir Etylin from Chukotka in Russia said: *"I consider a ban on castrating as a serious threat to all reindeer husbandry. We look at reindeer as part of a herd. Such a herd is itself a living organism where every animal has its own place, reindeer cows, calves, and reproductive bulls. Castrates do have their own place in the herd's structure too. Humans would not have been able to domesticate reindeer without using castration. It is one of the corner stones of the domestication process. I have studied this theme with special care and have come to the conclusion that this problem is a very serious one. Without castrates it is not possible to build up a controllable reindeer herd. Castrates have many functions in a reindeer herd. The first one is that they are the calmest animals of a herd. This means that a reindeer herd with castrates quiets down easily. This is one function. Another one has to do with transport. Castrates are the best transport animals. Reproductive bulls cannot be used for transport during and after rut. There are also problems connected with the use of reindeer cows. But not with castrates. For example: In Chukotka it is impossible to survive without crushing ice during a so-called black ice period, when everything gets covered with a layer of ice. When this happens only the castrates are strong enough to break such ice. Reproductive bulls are first to die because of lack of food. Calves die very quickly too. But castrates are the strongest animals and they manage to break such ice. Reindeer cows follow after them and eat the fodder left over. When there is a lot of snow, they are the first ones to dig the snow away. After that they are chased away and then the reindeer cows can eat"* (Reindeerportal 2008). In 1732, Carl Linnè, described castration of reindeer: One person keep the 2.5 years old male in the antlers 14 day before Michaels mess, while the herder use his teeth to bite across the reindeer balls, and subsequently use his finger to carefully massage the epidemic, avoiding to harm the skin. Castration of males are also common throughout whole Eurasia, in 2002 Norway banned the traditional castration of male reindeer due to animal welfare reasons, and thereby could have increased the vulnerability of the livelihood to future effects of climatic change (Tyler et al 2007).

Furthermore, reindeer herders maintain high levels of phenotypic diversity in their herds with respect, for example, to the age, sex, size, color and temperament of their animals (Oskal, 2000). Traditionally, the percentage of males in the herd could be as high as 40%, contrasting to only 5-10% in reindeer herds modified according to a European sheep production system with only high yielding individuals. High ratios of

male reindeer in the herd are seen in most places throughout Eurasia. Their strength enables them to dig through deep snow and thick ice, using the hooves, when winter grazing conditions are poor, making highly digestible pasture plants available for the small calves and yearlings in the herd. Studies of herd structures in the light of survival strategies for the whole herd on snow-covered ground are one of the ways how to gain more insight into traditional herding strategies. In a pilot project carried out by two of the researchers engaged in EALÁT compared the knowledge a biologist and a traditional reindeer owner had focused on through many years of observations of a reindeer herd. The important facts for the biologist had been age, weight development, reproduction abilities, health condition and genealogical facts of individual animals. The owner had focused on general appearance, behavior, mobility, willingness to follow or lead other animals, position in the herd in grazing situations and on the move, ability to defend the calves, condition in the spring, the ear marks and ownership of the animals and other aspects that had to do with the survival of the herd as a whole. (Tyler & Magga 2002)

3.3 Reindeer herders' language – Special language

Using consistent, clear and relevant language in a subject helps to improve communication. For this reason, we are collecting field data in Sámi in natural situations and with the active participation of the herders themselves. Such communication is only possible if unambiguous terms are established for well-defined concepts and if these terms are known and used consequently. Our basis is the traditional language. One of the main objectives of the eight research packages within the IPY EALÁT project is to document indigenous knowledge about snow conditions and how reindeer herders' are adapting to changing conditions in relation to snow.

Language plays a key role in structuring of knowledge and knowledge sharing (von Krogh et al. 2000). It is through language that traditional knowledge is available. (ICR: 2007b). Language is partly divided into two domains of communication: general language and specialized language, which is a language for a restricted type of communication, i.e. medicine, law etc. Communication is defined as a process by which we assign and convey meaning in an attempt to create shared understanding. This process requires a vast repertoire of skills in intrapersonal and interpersonal processing, listening, observing, speaking, questioning, analyzing, and evaluating. It is through communication that collaboration and cooperation occur. The most important factors are common understanding and clear technical concepts and terminology use. One needs to describe concepts, to distinguish between concepts, to classify concepts within a conceptual system.

Terminology is instrumental for the systematization of concepts. It is of basic importance for the structuring, analysis, and description of knowledge within a special field and for the transmission of this knowledge to a broader public. (Nuoppunen 1994:30) For this reason it is not only natural but also necessary to use terminology as a basis to systemize the traditional knowledge of the reindeer herders. In this project we both collect and analyze existing concepts that are used in Sámi reindeer herding language. These are the concepts that have been developed during life long experiences, in response to needs within reindeer herding, where people work

together in order to make a living by exploiting the possibilities of their natural surroundings.

3.4 Sámi language

The Sámi language is spoken in four territorial states, Norway, Sweden, Finland and Russia. The Sámi area stretches from the south (Femunden in Norway, Dalarna in Sweden) and northwards to Utsjoki in Finland, Varanger in Norway and the Kola Peninsula in Russia. The whole area of Sámi settlement constitutes the area for the Sámi language. The Sámi language is not a majority language in any of these states. In essence Sámi is a 'stateless language', but the territorial borders divide the Sámi language boundaries. (Eira 2004:86-87).

In many areas there is a rich traditional terminology which mirrors the ways of understanding nature. In addition to reindeer herding, traditional livelihoods have been fishing, hunting, farming and duodji (handicraft) – everyone with their particular vocabulary. There is a strong tendency in the Sámi language towards a strong specialization in some fields. Many terms can not easily be translated into other languages. Other fields of specialization are kinship terminology and landscape terminology. To mention one example, kinship relations are described in detail with distinctions between younger and elder uncles and aunts on both sides like *goaski* 'mothers elder sister' vs. *muo##á* 'mothers younger sister'. On the other hand, with the introduction of new technologies like snow scooters and other equipment, the need for terminology development is urgent.

Reindeer herding terminology and phraseology has a strong foothold in the Sámi language. The Sámi language mirrors the thorough knowledge of the Sámi about nature and landscape. In this way the language shows the ability of the Sámi to know how to manage the landscape they live in.

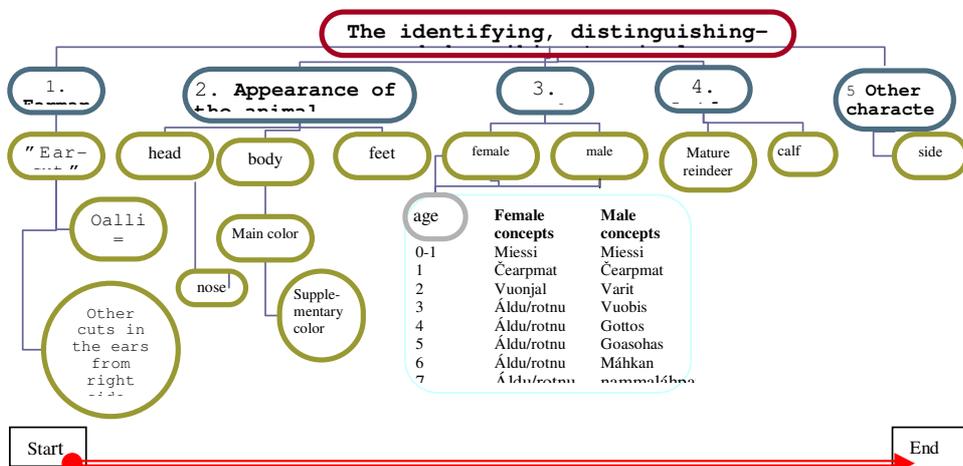
3.5 Some examples of Sámi reindeer herding terminology

The development of reindeer terminology has occurred in the light of necessity and of crucial importance in the communication between reindeer herders about reindeer herding, characterizing the snow condition, describing the animals etc. The need for terminology for reindeer comes from the fact in good reindeer herding practice, there is a need to identify and describe animal for various purpose. (Magga 2005:4).

Indigenous Classification systems can be very different from western ways of classifying observations about nature (Magga 2005:3). In Sámi language, particular in reindeer herding, there is a well developed vocabulary regarding reindeer herding, reindeer and topics that are affected by reindeer herding. There is a rich terminology with reference to body shape, body condition and behavior characteristics. (Magga 2005:5) In EALÁT we are collecting information on concepts, documenting terminological information and documenting terminological diversity. In the dialect of Guovdageaidnu/Kautokeino, there were found to be over 1000 individual terms regarding reindeer, primarily regarding their appearance (Eira 1984), for example there are some 50 words about the shape of the antlers and then there is the color, the feet, the head, the nature of the coat and the earmarks (Magga 2005:5)

3.5.1 A model of reindeer herders' identifying, distinguishing and describing terminology

Reindeer herders need an extensive array of skills when managing a reindeer herd. It is important to be able to distinguish between the different animals in own herd and in herds that belong to others. If a herder is asked to give a description of a reindeer, he/she must be able to recognize individual animals, identify the ear-marking of the reindeer and connect it to the owner. The herder must characterize and describe the animal (reindeer) by gender, color, antler etc. Reindeer herders are using this model in a communication situation where a herder is expected to be able to identify, distinguish and describe a single animal to another herder. It is divided in five parts. 1) The herder describes the earmark. 2) The herder describes the appearance of the animal, the color of the body, head and feet 3) it is the gender, see the description in, as an example on this. 4) It is the description of the antlers. Every piece of the antler and every antler form have its own names. There can be a lot of different combinations that give a lot of terms to the different antlers and 5) If there are other significances of the animal, the herder describes them. Here is a model that shows identifying, distinguishing and describing terms and concepts in context of their relationships provide valuable conceptual information in a communication situation.



Magga writes that the most advanced system for describing the appearance of the body is the color terminology (Magga 2006:27). The basic dimension is the scale from white to black and main grade on the color-scale goes from lighter to darker colors. In addition the colors are divided into levels, the main color level and supplementary colors.

The earmark system is common for Sámi reindeer herders. This system is very old and it has been the best system to distinguish who the owners of the animal are. No one has invented a better system of how to mark reindeer. Reindeer marks are regulated by law. In North Sámi the earmarks system has 15 different cuts, with their own concepts, which have been combined and put together. If we quantify all the combinations, then theoretically there are probably millions of combinations, but because of functionality and due to family traditions all combinations are not used.

The rule of thumb is to describe the main cut “oalli”, which is on the right ear on the upper side, to represent the kinship identifications. Then the other cuts from right side to the left.



Here are some examples of reindeer earmarks. As you can see below, no earmarks are similar to others. Every owner of reindeer has their own mark.

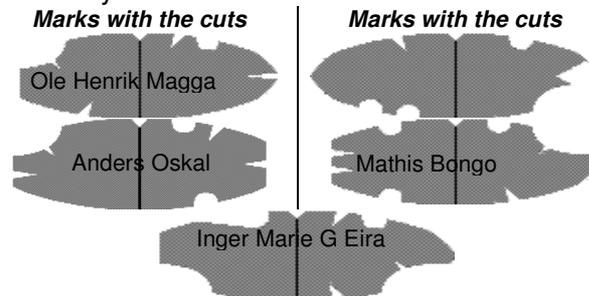


Fig. Reindeer earmarks with owner names

With the help of descriptive terms one can describe every small detail of an individual animal. These concept systems have a very high rank of specialization which is a necessary part of reindeer herders' communication.

4. SEASONAL WEATHER AND CLIMATE CHANGE - PRELIMINARY RESULTS EALÁT

4.1 Reindeer herding and effects of climate change.

ACIA concluded that the Arctic is warming faster than previously thought and that indigenous peoples will experience substantial challenges to their economies and their cultures as a result. The reindeer herding pastures are probably the areas where warming is going to be most significant for the next 30-50 years.

Reindeer herders and their reindeer live for 8-9 months a year in a world of snow, in relatively extreme environments with interchangeable climatic conditions. Through the year, temperatures can vary from +25 degrees Celsius to -65 degrees, with weather and climate conditions continuously changing. These are circumstances both reindeer and herders are adapted to. In a way, one could say that the reindeer herding cultures themselves represent an adaptation to extreme climate and variability. (Pehrson 1964)

Climate change perspectives represent a new challenge for adaptation. There is an urgent need to document the changes reindeer herders are subjected to and the herders traditional knowledge related to the ecology, economy and adaptation to these changing conditions. For example, inner Finnmark is used as winter pastures by reindeer herders in Norway.

Models predict that the mean temperature and precipitation in these areas may increase by as much as 0.7 C and 10 % respectively per decade during this period which can affect the pastures in a variety of ways that may influence conditions for reindeer.

Increased temperature in autumn may lead to a later start of the period with snow cover. Increased temperature combined with more frequent precipitation may increase the frequency of snow falling on unfrozen ground. This can delay both the arrival of snow, as a result of which the reindeer tend to disperse and the herds become less easy to control, and also the formation of thick, safe ice over rivers and lakes, consequently impeding the

movement of herds inland. Increased precipitation in winter can result in greater accumulation of snow on winter pastures resulting in a general reduction in the availability of forage. Increased precipitation in winter may contribute to increased snow depth over the high ground where reindeer graze. The melting period in spring will probably start earlier but the last date of melting may be significantly delayed as the initial snow cover will probably be deeper.

The physical structure of the snowpack may also be affected by the projected changes. Swift changes in temperature, which seems to be one of the elements of change we will face, most certainly will produce more hard snow and ice. In particular, the frequency of rain on snow and of periods of melting during winter which will result in the formation of ice or crust-layers (Forchammer and Boertmann 1993, Tyler et al 2007) may increase.

4.2 Snow terminology and local weather, climate variability and change from the reindeer herders' point of view.

For the indigenous people of the Arctic, the understanding of snow and ice has always been necessary for survival. (Nichols et al 2004:69). Sámi reindeer herders use some 200-300 different analytical terms for snow in relation to reindeer herding which shows the importance which snow has had and has for reindeer herding and for the livelihood of the reindeer herders. Knowledge about snow and snow condition has not been developed by chance, but because it is necessary in order to survive under extremely challenging and constantly changing climatic conditions. A basic requirement is the knowledge how to differentiate between different snow profiles.

Snow has a complex microstructure which constantly changes. Snow can fall under different weather conditions. When the ground surface constantly receives new snow under changing weather conditions, the resulting snow cover will exist of different layers. The binding forces between these layers and between the lowest layer and the ground surface can all be of a different character and be of different strength.

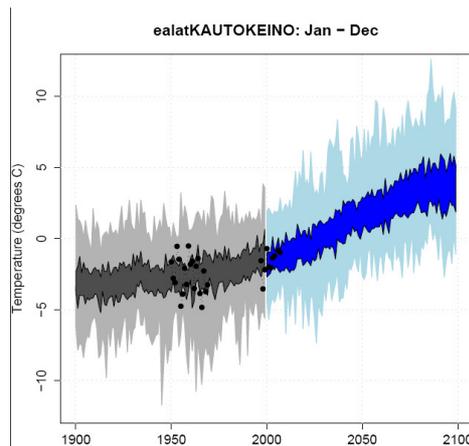


Figure: Statistical downscaling of mean winter past and future temperature in Guovdageaidnu/Kautokeino, based upon 11 global models under A1B. (Benestad et al. 2008)

Snow on the ground, snow cover, amount of snow, thickness of snow cover and snow consistency, difference in snow layers in different areas, in different times of the year and under different weather conditions decide the possibilities for the reindeer to dig through the snow in order to get to their food. The consistency of the snow has decisive influence on winter grazing possibilities (Ruong 1964:79).

So far we have focused on North Sámi snow terminology and its use. This is a conceptual system with many details and a huge vocabulary in use in everyday work. Especially there is one term herders are using a lot in winter time, which is *guohtun*. On snow-covered land *guohtun* simply means “possibility of the reindeer to finding reindeer moss [and other food, our addition] under the snow” (Nielsen 1932-62, 1979 II:232, translations in “...” are from this dictionary). The herding strategy during the winter is to provide for the herd to find *guohtun* with lowest possible energy cost for digging and movements, and at the same time have control over the *siida*-herd. For herders the starting point is *oppas* “untouched, untreaded, covering of snow (where no way, road, has been made by walking or driving, or where reindeer have not grazed), deep snow, untreaded reindeer pasture in winter”. Every animal should be able to dig or find a *suovdnji* which is “grazing hole, hole dug by reindeer in the snow in order to feed”. The grazing and movements of reindeer will make *čiegar* “snow-field which has been trampled and dug up by reindeer (...) feeding there”. Normally, *čiegar* will make it impossible to use the same area again during the same snow seasons. In wider concept it is *fieski* which means “area where a grazing herd of reindeer has been (including all kinds of tracks, not only *čiegar*)”. A successful reindeer herding depends on a good analysis of the day-to-day situation, but even more on an overview of the expected development during the whole snow season.

The quality of snow can be assessed along several dimensions (Jernsletten 1994, Magga 2006). Here are some of them:

CONSISTENCY	THICKNESS	LAYERS	HARDNESS	WATER CONTENT	PROCESSES
<i>luotkku</i> “loose snow	<i>bohkolat</i> “deep snow of varying depth	<i>geardni</i> “thin crust of snow	<i>časttas</i> “hard snowdrift (smaller than <i>skálvi</i>)	<i>njáhcu</i> “thaw”,	<i>borga</i> ‘falling of snow’
<i>seajaš</i> “granular snow at the bottom of the layer of snow	<i>skálvi</i> “big (high, steep and usually hard) snow-drift	<i>skárta</i> “thin (more or less ice-like) layer of snow frozen on to to the ground	<i>čearga</i> “snowdrift which is so hard that it bears; crust of drift-snow”	<i>soavli</i> “very wet	<i>guoldu</i> “cloud of snow which blows up from the ground when there is a hard frost without very much wind

A more systematic comparison with the ICS nomenclature is in process.

We are investigating what types of snow or the snow cover gives either good *guohtun* or bad *guohtun* in reindeer herding. One of the factors of great importance when analyzing *guohtun* and snow is the topography (landscape). The form of the landscape decides the distribution of snow over the area. This must also be seen in connection with the predominant wind direction. The best winter area for reindeer includes tundra (*duottar*), the English word is in fact a Sámi loanword), woodland (*vuopmi*), open, treeless ground in woodland (*vađđa*) and marsh (*jeaggi*). The use of the grazing areas in wintertime must be planned according to snow conditions and energy considerations (Sara 2001:46). The optimal use of the landscape depends on

knowledge of the land itself and the assessment of factors that determine the snow conditions. This knowledge constitutes intense, highly functional local geographies (Riedlinger et al 2001:316) Successful herding is also dependant on the mobility of the herders and animals.

4.3 Reindeer herders' observations and characterizations

Reindeer herders are monitoring very large variables considering reindeer and snow conditions. Indigenous knowledge pursues holism by considering a large number of variables qualitatively, while western science tends to concentrate on a small numbers of variables punitively (Berkes 2008:197). They are looking at the behavior of the herd, condition of the animals, the temperature, the moisture, wind. They are using two rules of thumb; 1) looking at the leading edge of the herd and 2) checking the hardness of the snow and looking at the snow profile. Rules of thumb that cut across complexity are one way to grasp how indigenous knowledge systems might deal with ecosystem complexity. Prescriptions in the form of rules of thumb have the advantage of turning complex decisions into rules that can be remembered easily and enforced locally through social means. (Berkes 2008:183) Examples how herders are monitoring and assessing the *guohtun*-situation and making decisions based on the actual situation and the expected development is: If the ground surface of a snow free area freezes in autumn while it is wet – this causes *bodneskártá* - then the reindeer herders say that it is best to sell as many reindeer as one can because such a condition means a sure catastrophe in the wintertime. This condition will not change until springtime comes and the natural warmth of the earth will change the hard ice snow into grainy snow.

Characterization of *guohtun* depends on the relationship between prediction, temperature, wind direction and velocity and other environmental variables. The science of snow uses many indicators at each level. Some of these, but not all, levels seem to be useful for reindeer herders. It is particularly important to document and analyze the processes that change snow conditions. In this analysis, precipitation and temperature are of course the basic factors. But in addition, it seems that we have to consider temperature differences between layers and temperature changes.

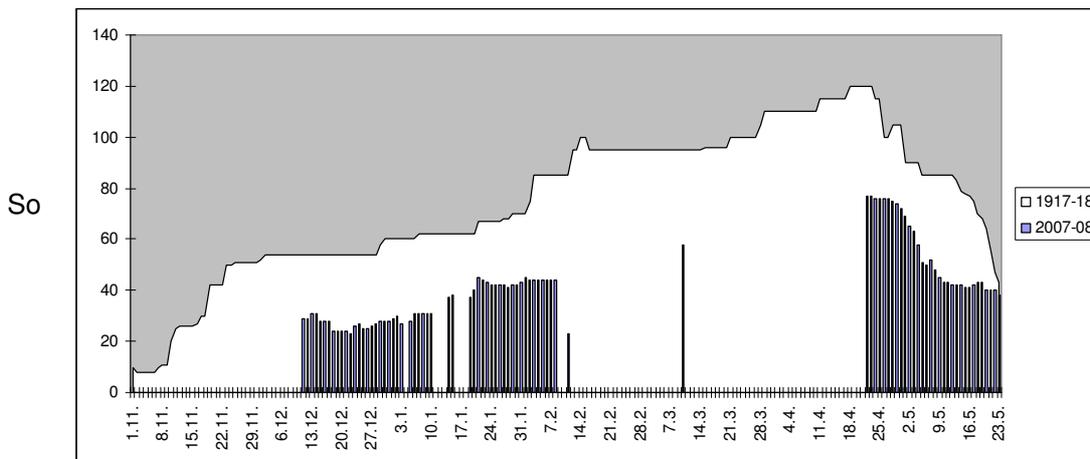
4.3.1 Using historical observation and observations from 2007/2008

EALÁT RESEARCH is using historical observations and observations from our project period. Historical observations are by interviews done in the Sámi community, which include oral history, elements of knowledge and stories passed on by parents and grandparents. In Sápmi, storytelling is still a living art. E.g. many elder herders in Guovdageaidnu/Kautokeino describe extreme (snow)years in their stories of herding and migration from the winter areas to the summer areas. Years such as 1917-18, 1933 and 1968 are described as bad years (*goavvi*) for reindeer. In 1917-1918 there was hard ice layer in the snow pack when it was simultaneously snowing a lot. That resulted in a lot of reindeer deaths because they could not feed. This history provides a context for change, as depicted in the following oral, description of long ago offered by an elder reindeer herder from Guovdageaidnu/Kautokeino called *Niillas* (born in 1909) told in 1980 (on tape) about an extreme (snow)year which was a very bad year for the reindeer. Here is a part of his story:

“...ja dat lei nealgedálvi, mun ledjen vissa gal 7jahkásaš. Diet dat lovtii olbmui ealuid. Mii láviimet lulde johttit, de gal šattai nealgečakča juo. De áhčči ja diet johte Bađaávžái ja doppe lei buorre ealát. Dat eai jábmohallan. Mu eadni lávii Siebes mannat. Na doppe nealgebohccot birra viesus vázzit...nealgebohccot. -Manne šattai nealgi? Diet lei ovdalaš juovllaid, de borggai hui gassada die dalle čakčat ja de arvvi hirbmadit ja de šattai dán asu jiekŋa dego dát beavdi. Ja de gal šattai nu nealgi, ealut bieđgane, manne juohke sadjái...vázze viesuid birra juohke sajis gos lei rihpa, nealgebohccot. Dat ii lean suohtas jahki. Áddjá ja mu eadni oruiga gođiin. Eallu manai dohko davás. Dat vedde 3-4 hearggi vai beasset márkanis niestti viežžat. De čulle jiekŋalaiggahagaid, laigejit eatnamis eret, ja go jorgalit daid, das lea jeagil gitta. Dal lei albma nealgedálvi, eai leat šat gullan dakkáriid manjit áiggis. Jiekŋa lei nu assái ahte ii dan beassan boazu čađa. Dalle unno ealut.”

He reminisced this bad year when reindeer were starving, not because of there is being little to eat, but because of the bad snow condition. A lot of reindeer died, the herds became smaller. He characterizes this year as *nealgedálvi*, ‘the year when the reindeer starved’. Reindeer could not reach the lichen because the ice layer was as thick as a “tabletop”, estimated to 10 – 15 cm. It was snowing a lot before Christmas, and then it started to rain and then the wet snow was freezing. The snow pack became so hard that they had to break up/carve the ice layer to get grazing hole. The reindeer could not get through the ice.

We have used these kind of stories and meteorological data (www.met.no) from an area nearby Guovdageaidnu/Kautokeino in 1917/1918 to compare and combine the two kinds of data. The story that Niillas told exist in the graph. In December 1917 the snow depth was nearly 60 cm and in April 1918 the snow depth was 120 cm (the white part in the graph). The dark poles in the graph represent same period (fall – spring) in 2007-2008. As can be seen, there is a big difference in snow depth between 1917/1918 and 2007/2008, which has resulted on two significant deferens in *guohtun* characterization, which are very bad and quite good *guohtun*.



extreme were snow conditions in the winter of 1917/18, with ensuing loss of animals, that Sámi herders in Norway employed Finnish settlers to dig snow to improve access to forage (McCarthy et al 2005: 975). The reindeer herder remembered this winter because of this extreme event, this crisis. The unexpected and extreme events an unusual fluctuation creates hardships because they interfere with the ability to access the various resources on the land, and make resources availability itself less predictable. (Fast & Berkes 1998)



ERROR: undefined
OFFENDING COMMAND: R"&:PId!X6^

STACK: